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Before the
FEDERAL COMMUNICATIONS COMMISSION
WASHINGTON, D.C. 20554

In the Matter of	)	
	)	
Application by New York Telephone Company	)	
(d/b/a Bell Atlantic-New York), Bell Atlantic	)	
Communications, Inc., NYNEX Long Distance	)	CC Docket No. 99-295
Company, and Bell Atlantic Global Networks, Inc.,	)	
for Authorization to Provide In-Region,	)	
InterLATA Services in New York	)	

DECLARATION OF
DR. ROBERT A. MERCER
ON BEHALF OF MCI WORLDCOM, INC.

I, Robert A. Mercer, hereby declare and state as follows:

I. INTRODUCTION

1. This declaration describes the ability of Bell Atlantic - New York ("BA-NY") to engage in anti-competitive technical discrimination against its interexchange carrier ("IXC") competitors in the provision of local exchange and exchange access services if it is allowed to enter the market for in-region interLATA services under the provisions of Sections 271 of the Communications Act. The evaluation considers both local exchange and exchange access services because, as explained in Section IV, BA-NY is in a position to disadvantage its IXC competitors in the provision of inferior interLATA access, in the interconnection of its local exchange networks with those of the competitive local exchange carrier ("CLEC") operations and/or partners of its IXC competitors, and in the supply of unbundled network elements to CLECs should they need to lease them from BA-NY.

2. The declaration also deals with discrimination against Internet Service Providers ("ISPs"), showing that ISP transport services are not fundamentally different than the services offered by IXCs, and in fact the distinction between IXCs and ISPs is increasingly blurred. The evaluation includes in its scope voice and other narrowband services, broadband data, broadband, and imaging services, and integrated networks that support both narrowband and broadband services.[1]

3. The remainder of this declaration is organized as follows. Section II sets forth my qualifications. Section III provides a summary of the conclusions reached in the declaration. Section IV presents a view of key marketplace and technical developments currently taking place in the local exchange network. It is necessary to understand these developments in some detail in order to understand the opportunities for BA-NY to discriminate against its competitors. Section V analyzes the incentive, power, and ability of BA-NY to engage in anti-competitive technical discrimination against its competitors if it is allowed to provide in-region long-distance services.

II. QUALIFICATIONS OF DR. ROBERT A. MERCER

4. I am the President of HAI Consulting, Inc. ("HAI"), a telecommunications consulting firm created in 1997 from the employees of the former Hatfield Associates, Inc. The firm specializes in engineering, economic, and policy studies in the telecommunications field. A copy of my resume is attached.

5. I received a Bachelor of Science degree in Physics from the Carnegie Institute of Technology (now Carnegie-Mellon University) in 1964, and a Ph.D. in Physics from Johns

[1] The distinction between narrowband and broadband services is defined in Section IV.B.

Hopkins University in 1969. After holding a faculty position in the Physics Department of Indiana University from 1970 through 1973, I joined Bell Telephone Laboratories in 1973. From then until 1984, I held a number of positions of increasing management responsibility at Bell Labs and at the AT&T General Departments, culminating in my position as Director of the Network Architecture Center at Bell Labs. In that capacity, I directed an organization that was responsible for planning and systems engineering for the Integrated Services Digital Network ("ISDN") and for advanced data services.

6. Upon the AT&T divestiture in 1984, I transferred to Bell Communications Research ("Bellcore," now Telcordia Technologies), where I was the Assistant Vice President of Network Compatibility Planning. In that capacity, I managed Bellcore's support of the BOCs in meeting the technical equal access requirements of the Modification of Final Judgement ("MFJ"),[2] conducted technical fora with the IXCs and other carriers on behalf of the BOCs, managed the North American Numbering Plan, directed Bellcore's involvement in standards-making efforts, and directed technical analyses of various federal regulatory matters, including an ISDN inquiry, the application of Computer II rules to the divested BOCs, Computer III, and Open Network Architecture ("ONA"). I also played a substantial role in the formation of a new U. S. standards committee, Committee T1, and was a member of the Board of Directors of the American National Standards Institute ("ANSI").

7. Leaving Bellcore in late 1985, I held positions with BDM Corporation and AT&T Bell Laboratories before joining Hatfield Associates in early 1987. Since then, I have served as Senior Consultant, Senior Vice President, and President of Hatfield Associates and HAI. At HAI, I am responsible for research and education related to public and private

[2] United States v. AT&T, 552 F. Supp 131 (D.D.C. 1982).

telecommunications infrastructures, with a particular emphasis on the Internet, broadband integrated networks, intelligent networks, local exchange competition, and private enterprise networking.

8. For the past three years, I have been heavily involved in the interconnection, unbundling, and resale issues arising from the 1996 Act (the "Act"). In particular, I have played a key role in the development of the HAI Model, which estimates the forward-looking cost of providing basic local exchange service and unbundled network elements. I have made presentations related to the Model in FCC workshops, and have filed testimony, testified, and/or made presentations on the Model before regulatory bodies in numerous states, including California, Colorado, Iowa, Kansas, Maryland, Massachusetts, Minnesota, New Jersey, Nevada, New York, Oregon, Pennsylvania, Texas, Utah, Virginia, and Washington. I have also discussed the Model and related costing issues with regulators in Mexico and Australia.

9. I have testified on a variety of other telecommunications issues before various state Commissions and in Canada. For instance, I testified on the extent and viability of local competition before the Illinois Commerce Commission in 1994; on Southern Bell's ONA plans before the Georgia Public Service Commission in 1993; and on Comparably Efficient Interconnection and Open Network Architecture before the Canadian Radio-Television and Telecommunications Commission in 1993.

10. In the past, I have dealt extensively with the FCC's ONA and Video Dial Tone ("VDT") concepts and related proceedings. I am a co-author of the "Hatfield Report"[3] on the

[3] "Open Network Architecture: A Promise Not Realized," paper filed with the Federal Communications Commission in connection with Third Computer Inquiry proceeding (CC Docket No. 85-229), April, 1988, co-authored with Dale Hatfield.

implementation of the ONA concept, and of *The Enduring Local Bottleneck* ("ELB-I"),[4] which deals with the ability of alternative providers to enter the local exchange telecommunications business. More recently, I co-authored *The Economics and Technology of Broadband Deployment*, a report that addresses the prospects for broadband competition and the need for competitive safeguards in broadband markets.

11. I am currently an adjunct faculty member in the Interdisciplinary Telecommunications Program at the University of Colorado, where for several years I taught a graduate level course on advanced data communications and computer networking and currently participate on thesis committees for the Master of Science in Telecommunications degree. I have also served as an adjunct faculty member at Pace University, teaching courses and seminars on telecommunications topics ranging from network management to voice communications to ATM and other fast packet switching technologies.

12. As a result of these activities in a variety of different positions with different firms and universities in several different contexts, I am thoroughly familiar with 1) the technology of local exchange and exchange access services, both in their existing largely-narrowband form and in their increasingly important broadband, packet switching form; 2) the technical and operational relationships between BOCs and Competitive Local Exchange Carriers ("CLECs"), and between BOCs and IXCs, that are required if local exchange service is to flourish and if exchange access is to be provided in a non-discriminatory fashion; and 3) the technical and operational issues raised by BOC applications, under Section 271 of the 1996 Act, for authorization to provide interLATA services.

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[4] Economics and Technology, Inc./Hatfield Associates, Inc., The Enduring Local Bottleneck:

III. SUMMARY AND CONCLUSIONS

13. In general, the vast majority of the users of telecommunications services, and especially residential customers, currently rely on the incumbent BOC for both exchange and exchange access services, and will likely continue to do so for many more years. The limited availability of competitive alternatives means that the concerns about anti-competitive discrimination on the part of the BOC that have arisen in the past will continue to exist for the foreseeable future. This concern is not alleviated to the extent that the growth of alternative suppliers is based in whole or in part on using the BOC's unbundled network elements or resold local exchange services, because the BOC can discriminate against those suppliers in the elements it provides them and therefore hamper their ability to supply exchange access to the IXC's.

14. If BA-NY is given the authority to enter into in-region interLATA markets, it would have all the opportunities it had to prior to the passage of the Act to undertake anticompetitive discrimination against its competitors. Moreover, it would have additional opportunities to engage in such behavior, brought about by new developments in the local exchange marketplace and in exchange network technologies.

15. Key developments in the local exchange marketplace, and the opportunity for increased discrimination they provide, can be summarized as follows:

- There is a tremendous growth rate in the Internet. This means the effect of discrimination by BA-NY in providing access to the Internet services provided by its IXC competitors will impact Internet users far more quickly than has been the case with users of voice services in the past. This discrimination will be directed against the Internet Service Provider ("ISP")

Monopoly Power and the Local Exchange Carriers, 1994.

operations of BA-NY's IXC competitors and against other ISPs as well, motivated by the revenue potential of ISP services;

- The emergence of broadband data transport services, both those associated with the Internet and with other networking initiatives of large corporations, provides BA-NY with the opportunity to discriminate not only in the provision of traditional narrowband exchange access and local exchange services, but also in the provision of these new broadband services;
- There is a growing interest in, although not yet certain technical success of, integrated networks that support all voice, data, and other broadband applications, currently focused on providing high quality voice services over the Internet. To the extent such integration occurs, discrimination by BA-NY against ISPs will become synonymous with discrimination against its IXC competitors;
- There is a continuing evolution of feature-rich voice services supported by the Advanced Intelligent Network ("AIN"). The advanced services and features enabled by the AIN provide the opportunity for providers to differentiate their services in the increasingly commodity-like transport business. To the extent AIN provides the opportunity for BA-NY to discriminate against its IXC competitors in the provision of AIN-based services and features, it can thereby gain a competitive advantage; and
- Finally, there is a growing emphasis on the part of telecommunications service providers to package a set of exchange, interLATA, and Internet services to customers, portraying themselves as offering "one-stop shopping." This trend gives BA-NY an opportunity to discriminate against competing IXCs beyond just the provision of exchange access to them. It can additionally discriminate in the provision of network interconnection and unbundled

network elements to the CLEC operations affiliated with competing IXCs, and in the provision of access to the ISP operations of those IXCs, thereby impairing the ability of the competing IXCs, their ISP operations, and their local exchange affiliates to provide such bundles of services in competition with BA-NY.

16. New technology developments can be considered to fall in two major categories. First, there are several technologies that increase the ability of BA-NY to deploy integrated fast packet switching networks that support voice,[5] narrowband services, and a range of broadband services. These include a new broadband loop technology, Digital Subscriber Line ("DSL"); fast packet switches in the central office; and interoffice broadband transmission systems. Second, intelligence is being added to the network, both in the form of intelligent call processing associated with voice calls and in broadband applications running on processors within the network.

17. My analysis of these technologies leads me to conclude that their deployment will both increase the opportunity for discrimination and make it more difficult to detect. In the process of automating and otherwise facilitating the many tasks associated with planning, deploying, and operating a network, and of supporting new services and features, these technologies may be used to greatly improve the quality, reliability, efficiency, and usefulness for all users when they are deployed and operated in a competitively neutral fashion. By contrast, they may have no impact, or a negative impact, where they are not deployed, or are operated in a discriminatory fashion.

18. The existence of these new technologies may be used to produce greater differentiation between "have" and "have-not" parts of the network, and specifically between the quality of

services provided to BA-NY's IXC operations and those of its competitors. Such discrimination can take place at many phases of a technology's life cycle, from its definitional and planning stages, where BA-NY may decide to apply the technology in a self-serving way, to the operations phase, where BA-NY's selective response to the need for maintenance and restoral activities may lead it to experience higher quality and availability than its competitors.

19. In summary, any BOC, such as BA-NY, with monopoly control of bottleneck facilities has both a growing incentive and an increasing ability to discriminate against its IXC competitors by the actions it takes in local exchange, exchange access, and Internet access markets. Recent telecommunications marketplace developments both increase the incentive of BOCs to discriminate and make the effects of such discrimination more pronounced. Given the rapid growth of the Internet, the reliance of ISPs on IXC services, and in fact the blurring of the distinction between IXCs and ISPs, discrimination against IXCs has a particularly strong impact on the competitors and on society as a whole. New technology developments increase the opportunity to discriminate in the provision of services needed by competitors and make such discrimination more difficult to detect.

20. Section 272's requirement that BA-NY provide in-region interLATA services through an arms-length subsidiary does not eliminate concerns about the types of technical discrimination discussed in this Declaration. The opportunities to differentiate in favor of the BA-NY IXC operation in the planning, provisioning, administration, and maintenance of circuits that connect the operation to the BA-NY local exchange network are the same whether the IXC operation is in a subsidiary or fully integrated with the local exchange operation.

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[5] The jury is still out on the value and success of integrating voice applications with broadband data services.

IV. MARKET AND TECHNOLOGICAL DEVELOPMENTS IMPACTING THE EXCHANGE NETWORK

21. A metamorphosis in the telecommunications market is underway. Services, players and the technologies utilized in the local exchange are rapidly evolving.

22. This section discusses key trends in exchange network markets and technologies, and the effects of discrimination that BA-NY can practice against its competitors as a result of these developments. The following section then evaluates how BA-NY can actually practice such discrimination during the various phases of planning, deployment and operating networks; it also gives specific examples of such discrimination.

A. Growth of the Internet

23. The Internet, which is the first ubiquitous public data communications network, is growing at a tremendous pace. Estimates are that every year, Internet traffic is at least quadrupling, the number of name domains is at least doubling, the number of users is more than doubling, and the number of attached computers is nearly doubling.[6] Furthermore, total Internet-based commerce -- the purchase of goods over the Internet -- is projected to grow from less than $1 billion at the end of 1997 to more than $200 billion in 2002.[7] Finally, the Internet already generates total revenues of over $300 billion per year; which is approaching the U.S. auto industry figure of $350 billion industry.[8]

24. Based on the available statistics, the Internet has grown more than 60 times larger in traffic volume and almost 10 times larger in users just since the 1996 Act was passed. By contrast, voice and other narrowband services grow much more modestly, at a rate no more than

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[6] Statistics derived from "Really Big Routers," Network World, 3/17/97, p. 1, and Colorado ISDN Interest Group Newsletter, May, 1998.
[7] Id.
[8] "It's Not Your Father's Oldsmobile," Network World, 6/21/99, p. 50.

5% per year in most areas, leading to a growth of less than 20% since Act was passed.[9] No telecommunications provider can afford to miss the opportunity afforded by the Internet. Nor can those that fail to address it long survive.

25. The good news about such a rapid rate of growth is that it provides the opportunity for entry by many providers of Internet services. The bad news is that the effects of discrimination by BA-NY will be felt more keenly and more quickly than has been the case with voice services in the past. As a result, if such discrimination is left unchecked, society will be deprived of the competitive provision of not only high-quality, intelligent, low-priced voice services, but also the competitive supply of the broadband telecommunications services that are of such importance to an increasingly sophisticated, bandwidth-hungry public.

26. The success and growth of the Internet is itself a key market development. In addition the Internet has spawned at least three other key developments. First, the Internet has caused the emergence of a new type of service provider, the ISP. The role of ISPs and their relationship to IXCs is key to the issue of BA-NY entry into in-region interLATA communications, so I will defer discussion of it until the following section.

27. Second, the Internet has motivated the growth of broadband transmission for sending data, video, and imaging information, which subsequently I will simply refer to as broadband data service. This has occurred as one of the most popular Internet applications, the World Wide Web, has created increasingly sophisticated web pages and content-intensive databases, such as video clips, images, and the like, to which they provide access, hence requiring large amounts of data to be downloaded from web servers to browsers.

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[9] Statistics derived from *Statistics of Communications Common Carriers*, Federal Communications Commission, 1995-1996, 1996-1997, and Preliminary 1998.

28. Internet technology, in conjunction with the growth of client-server computing to replace the former terminal-host computing paradigm, has also taken root in corporate networks. Here, "legacy" computer networks, such as those based on IBM's System Network Architecture, are being supplanted or transformed by web-based communications. Within a single corporation, such networks based on Internet technology are referred to as intranets. Multiple corporations, typically trading partners in a supply chain, also band together to create multi-company networks called extranets.

29. Whether considering the public Internet, intranets, or extranets, the key point is that such networks involve the movement of increasingly large amounts of data, and hence impose the requirement for broadband data transport services. The growing importance of such services creates new opportunities for BA-NY to discriminate in providing not only access to voice services, but to these broadband data services as well. Such discrimination provides BA-NY with a key competitive advantage, particularly with large business customers for whom broadband networking is key to success in the information age.

30. Third, as broadband data networks have grown in importance to users to the point of being equivalent to voice networks, interest is growing in integrating data and voice networks. This interest is heightened by the Internet's potential ability to serve as a replacement and enhancement for voice and other services customers otherwise purchase from the Public Switched Telephone Network ("PSTN"). Specifically, the Internet:

- Will potentially be able to support a full range of voice services and features, using what is often referred to as Voice over Internet Protocol ("Internet voice")[10];

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[10] Technical and implementation problems with this technology make it unlikely that it will be used on a widespread basis in the near term as a replacement for voice services provided over the PSTN.

- Already supports many services that are substitutes for, or augmentations of, voice service, such as chat rooms, electronic mail, and electronic commerce;[11] and
- Can provide corporate customers with Virtual Private Networks ("Virtual Private Networks"), discussed in more detail later in the Declaration, that appear to the user of such a network to have the attributes and features of a private network without actually dedicating routers or transmission facilities to the customer.

31. Such integrated networks could have a number of advantages, such as more efficient utilization (for instance, interspersing low-priority data in lulls between the transmission of higher-priority voice), consolidated management, and innovative applications involving a mixture of voice and data content. At the same time, there are substantial technical obstacles to the full integration of voice and data, having to do with the quality of the reconstructed voice signal and the effects of transmission delays and lost packets when voice is sent over a packet network. A substantial effort is underway to analyze and resolve these issues, including any protocol development that may be required.

32. Should the obstacles be surmounted, the Internet will likely evolve to play an increasingly important role in the provision of long distance voice services. As time moves on, then, the distinction between the "voice" network and the Internet may increasingly blur. As a corollary, there will be a blurring distinction between today's IXCs and ISPs, a point discussed further in the next section.

33. Finally, the success of the Internet has also spawned an interest in the provision of value-added applications services by companies who previously solely provided transport services, and

[11] For instance, a consumer can call an 800 or 888 number and place an order for a product with a salesperson, or can electronically order goods over the internet, thus the PSTN and Internet provide equivalent functionality for many consumers.

the bundling of such services with transport. This is most evident today in the provision of such applications by ISPs. They provide, for instance, protocol conversion services for non-Internet PCs, electronic mail, other Internet applications such as file transfer and remote terminal logon, web site hosting, and in some cases, advanced information services such as stock market quotations and airline ticketing. By doing so, they both attain the opportunity to earn revenues from feature-rich applications and to differentiate their offerings from those of other transport providers. This concept has not been lost on other IXCs, who are entering the ISP business or otherwise adding various kinds of applications to their arsenal of services. Nor has it been missed by the BOCs and other incumbent telephone companies.

34. The provision of such applications services is not taking further root in the concept of the Application Service Provider ("ASP"). ASPs are beginning to deliver processing-intensive and often bandwidth-intensive applications to their customers over the Internet.

35. The revenue potential and opportunities for service differentiation provided by such applications is attracting the attention of all providers of transport services, including the BOCs. They also provide additional incentive to discriminate in the provision of access to such services.

B. Blurring of the Distinction between IXCs and ISPs

36. The first specific Internet-related market trend identified in the previous section was the emergence of ISPs. ISPs typically provide a set of value-added applications to consumers, along with transport capabilities provided by third-party carriers, including ILECs and IXCs. The enhancements ISPs provide include for instance, protocol conversion necessary to support dial-up PCs, web hosting, and electronic mail. Internet backbone providers provide regional and national backbone networks that carry Internet traffic for themselves and other ISPs.

37. As long as interLATA restrictions apply to BA-NY, it has not been allowed to provide interLATA backbone services specifically. The lifting of the restriction on the provision of in-region interLATA services would, however, raise significant concerns about potential discrimination to the extent the BOC's monopoly power remains unchecked. This is true for several reasons.

38. First, with interLATA relief, BA-NY will be able to offer its own Internet backbone should it so desire. Such a backbone service would compete with equivalent services of BA-NY's IXC competitors and of other interstate backbone providers, so discrimination in the provision of access to Internet backbone services would become as much a concern as discrimination in providing access to any other long distance service.

39. BA-NY discrimination in the provision of access to ISPs is a very real threat. Bell Atlantic and other BOCs argue that they should be able to deploy a new broadband loop technology, ADSL, discussed in Section E below, to provide access for their own ISP exclusively. They claim that the requirement to share new technologies such as ADSL with other parties would act as a strong disincentive to deploy that technology. US West, in its reciprocal compensation case, goes so far as to argue that in its provision of DSL service it is not a LEC.[12] That would remove it from 251(g) obligations with respect to ISPs, although this is not specifically at issue in the case. Such opinions are not so much those of common carriers providing competitively-neutral basic transport services to all customers, including ISPs, but of companies that view themselves as providers of feature-rich ISP services, and wish to gain an advantage over their ISP competitors. Thus, not only must there be a concern about BA-NY leveraging its local exchange monopoly to disadvantage traditional interLATA competitors if it

obtains interLATA relief; this attitude also heightens concern about BA-NY behaving in an anti-competitive fashion against the ISP services of their IXC and Internet backbone competitors.

40. Second, the market distinctions between ISPs and IXCs is blurring in any case as 1) IXCs increasingly provide ISP services; 2) ISPs provide voice offerings that compete with IXC long distance services; and 3) Internet, other data services, and perhaps voice offerings are integrated on a single network provided by an IXC/ISP. Conceivably, BA-NY could even attempt to redefine itself as an ISP and thereby argue that it was not subject to any 251(g) conditions on its interLATA offerings.

41. Finally, BA-NY may choose to bundle local exchange, interLATA, and Internet services and offer attractive service packages to its customers. If so, the specific issues identified in Section C below come into play.

C. Bundling of Services by Telecommunications Providers

42. There is a growing interest on the part of telecommunications providers to offer a bundle of services to customers, rather than selling individual services to them. BA-NY has claimed in its application:

> Granting this application will do even more to promote local competition. The largest long distance carriers have recognized that, because Bell Atlantic will soon be able to offer both long distance and local service in New York, they need to accelerate their efforts to get into the local market so that they can offer local and long distance service as well. So MCI WorldCom has recently ramped up its efforts to win the local business of both residence and business customers, and AT&T is beginning to do the same. Authorizing Bell Atlantic to get into long distance will only hasten this trend.[13]

[12] Petition for Review, US West Communications, Inc. v. FCC, No. 98-1410, at 17-30 (D.C. Cir. filed May 17, 1999).
[13] BA-NY Br. at 3.

As highlighted in the previous sections, this bundling may include combinations of local exchange and exchange access services, interLATA services, Internet services, and various applications services.

43. To the extent that such bundling becomes commonplace in the telecommunications market, it heightens the effect of discrimination by BA-NY against its competitors. In a bundled environment, not only does BA-NY discrimination against competitive providers of one service give it an unfair advantage in the marketing of that service, but in addition it impacts the entire set of services offered by that competitor. Thus an IXC's desire to offer bundles of services is jeopardized by its reliance on BA-NY for access to any of its services. In effect, BA-NY can kill several birds with one stone.

D. Developments in Broadband Transmission Systems

44. At the outset of this section, I will first explain the distinction between narrowband and broadband transmission. Bandwidth was a term originally invented to describe the frequency range that could be sent over analog transmission systems. In modern usage, however, bandwidth much more commonly refers to the bit rate (that is, the number of bits per second) that can be transported by the transmission system or service in question.

45. Narrowband systems are those capable of bit rates of at most a few tens of kilobits per second ("kbps"). Bit rates of this order are suitable for supporting digitized voice and low-speed data communications. By contrast, broadband systems are those capable of at least hundreds of kbps and perhaps as high as tens of millions of bits per second ("Mbps"); as even more information-intensive network applications appear, the upper end of this range will move even higher.

46. Some authors restrict broadband to refer to bit rates of greater than one Mbps. This leaves a gap between the narrowband range of tens of kbps and broadband range of greater than one Mbps; historically, there have not been any significant service offerings whose bit rates fall in that gap. A few authors use the term "wideband" to describe bit rates falling between the narrowband and broadband ranges.

47. Because broadband services can support a range of voice, data, video, and imaging services, whereas existing narrowband services can only support voice and low speed data services, broadband is often, if loosely, differentiated from narrowband by stating the former supports all forms of telecommunications, whereas the latter supports only voice and low-speed ("modem-speed") data.

48. Fiber optics transmission systems are being deployed throughout the telecommunications network, including the local exchange. They are particularly prominent in the interoffice portions of local exchange and interLATA networks, but are also being deployed in the "feeder" portion of the loop, and there is a substantial potential for future use even in the "distribution" part of the loop.[14]

49. The initial fiber optics transmission systems were based on vendor-proprietary systems operating at a variety of non-standard transmission rates. This meant that the systems of two or more vendors could not be interconnected. This was particularly problematic in planning for "mid-span meets" between the systems of two or more networks provided by different entities, such as frequently occurs in exchange access.

50. As a result, as such systems were deployed, there was an increasing motivation for, and interest in, the development of standards for such optical transmission systems. This culminated

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[14] The terms "feeder" and "distribution" are defined in Section D.

in the late 1980's with the adoption of the Synchronous Optical Network ("SONET")[15] family of standards. SONET specifies standard line rates, optical interfaces, and signal formats. It is intended to create a transmission environment that encourages the ubiquitous deployment of high-speed fiber optics transmission, while lowering costs and providing a transport infrastructure that helps to simplify the network.

51. In addition, the SONET formats include a substantial amount of overhead that enables the development and deployment of operations support systems ("OSS") that communicate with each other and with the components of the SONET facility using the overhead bits. Such OSS will provide more rapid circuit provisioning, better monitoring of transmission performance to facilitate the early detection of problems, faster and more accurate maintenance, and automatic real-time network reconfigurations in the face of facility failures due to cable cuts and the like.

52. Concerning the last of these benefits, SONET is forming the basis for so-called "self-healing networks." Such networks are typically built in a ring configuration, providing two paths[16] between any two points on the ring, and allowing the system to transmit over whichever ring segment provides better transmission quality at any instant in time. Thus, if one direction of transmission fails, the SONET equipment simply switches to the other path around the ring.

53. SONET, and the sophisticated operations that it enables, allow major advances in the ability to rapidly, effectively, and accurately operate broadband transport systems. Such advances include circuit provisioning, facility and circuit monitoring and surveillance, maintenance, and network reconfiguration. At the same time, these advances can be realized only if sophisticated SONET-based operations systems are deployed. Where multiple network

[15] The international standards equivalent of SONET is the Synchronous Digital Hierarchy ("SDH").

[16] That is, the two ring segments connecting the two points.

providers share the same SONET transport facility, the different providers' systems must implement the same SONET standards and be configured to communicate with each other. This involves fairly complex OSS coordination between different – and often competing – entities. As a result, the potential benefits of SONET can be used by BA-NY to create an unfair advantage for them over their competitors if the systems are not operated in a competitively neutral fashion.

E. Developments in Broadband Networking

54. The enormous success of, and growth in, the Internet, discussed above, is fueling an interest in new network architectures and technologies that can deliver broadband services to the consumer. Among them are the following changes in the telecommunications infrastructure:

- The access network, or "local loop," is evolving from voice-oriented narrowband, analog transmission to integrated broadband digital transmission;
- Switching is evolving from voice-oriented circuit switching to integrated fast packet switching;
- Inter-switch transmission is evolving from voice-oriented narrowband circuits of 64 kbps bit rate, to integrated "bit pipes" that utilize the full available bandwidth to transmit a single bit stream supporting all applications; and
- Network service providers are increasingly found in the applications business, as they attach applications processors to the network.

55. In the local exchange, the infrastructure changes described above take the several specific forms. First, the existing voice switches in the COs to which customers are attached are being supplemented by packet switches and/or Internet routers that carry the Internet and other data/multimedia traffic. Going even further, some IXCs and LECs have announced the intention

of migrating their networks to a fast packet network which fully integrates the transport of information associated with all kinds of applications -- voice, data, video, etc.[17] In this scheme, all forms of communication, including voice, appear as a stream of packets from fast packet equipment on end users premises to and all the way through the network to similar equipment at other end users' and information providers' premises. A fast packet switch is married to the central office ("CO") end of the broadband access line at each end of the route, and serves as the entry point for the rest of the packet network.

56. Second, the capacity of existing fiber optic interoffice networks is being increased, and part or all of the available bandwidth is being used as an aggregate "bit pipe," rather than being organized into voice circuits. Finally, and perhaps most significantly, a new loop technology is being developed to provide consumers with broadband access. The new broadband technology is referred to as xDSL, where DSL is an acronym for Digital Subscriber Line, and the "x" indicates there is a family of such technologies. A number of different members of the family have been, or are being, defined. The several variants of ADSL are thought of as the technology most applicable to residences and small businesses; High-bit-rate DSL ("HDSL") is viewed as a cheaper, quicker way to provide conventional digital "T1"[18] dedicated circuits to the premises of larger businesses.[19] Other types of DSL include symmetric DSL, or "SDSL," a symmetric DSL configuration that can be deployed on loops up to 20,000 feet in length; and integrated DSL, or "IDSL," a symmetrical DSL configuration that can be deployed on loops up to 26,000 feet in

[17] See, for instance, "The Old Phone System is Facing an Overload, So Sprint Has a Plan," Wall Street Journal, 6/2/98, p. 1.

[18] T1 is a well-known transmission speed, involving a transmission speed of 1.544 megabits per second simultaneously in each direction.

[19] HDSL requires two wire pairs to achieve the two-way T1 signal. Symmetric DSL, or SDSL, operates over a single pair and can still achieve up to the T1 rate; however, there are more stringent conditions on the loops utilized.

length. IDSL is unlike all other forms of DSL in that it does not require "clean" copper loops from end-to-end (i.e., no interfering loop equipment such as load coils, repeaters and digital loop carriers, and minimal bridged taps). IDSL-capable loops can include repeaters and digital loop carrier systems.

57. The entire xDSL family is defined to operate over existing copper loops that meet certain conditions. In the case of ADSL, these conditions are stringent enough that it appears that at best two-thirds of presently-deployed copper loops will be able to support it.[20] The capability involves the attachment of xDSL terminal equipment to each end of the wire loop; thus one end is at the customer's premises[21] and the other in the CO. The high bit rates are attained through the use of sophisticated signal processing algorithms in the xDSL equipment.

58. ADSL permits a customer simultaneously to make a voice call and to send and receive data over a single wire pair. It is "asymmetric" because it transmits at a higher speed downstream (from the network to the customer) than upstream (from the customer to the network). The downstream signal bit rate ranges from hundreds of kbps to eight Mbps, depending on the loop length and electronics, with the lower end of this range being available out to 18,000 feet or more from the CO. In addition to the high-speed downstream signal, there can also be bi-directional signals whose bit rates range from 16-800 kbps.

59. The simultaneous presence of voice and high-speed data on a single line requires a signal "combiner/splitter" at each end of the loop, although the premises splitter may be included on the ADSL modem card inserted in the PC. Looking at the CO end, the signal passes through the splitter that separates the voice and digital signals, sending the voice signals on to the voice

[20] See, for instance, "Can't Get Enough DSL," Feature Article, Network World, 11/16/98, p. 55.

switch, and sending the digital signal to a DSL Access Multiplexer ("DSLAM"). The DSLAM separates (and combines, in the downstream direction) the digital signals that may be present. These signals are then sent to a fast packet switch, which may be an Internet router, Asynchronous Transfer Mode ("ATM") switch, frame relay switch, or another element, such as a video server if ADSL is being used to provide video services. Generally, the first ADSL application has been Internet access, so IP datagrams are transmitted over the ADSL loop and forwarded to an Internet router.

60. For all its promise, xDSL, as well as the associated link to an Internet router, has yet to overcome a number of limitations. For example, since loops must meet certain conditions to be suitable for particular forms of DSL, such as ADSL, more sophisticated loop administration is required to identify and assign appropriate loops when a customer orders service. Second, locating certain wire pairs in the same binder group as conventional T-1 lines with repeaters may interfere with certain types of DSL, and additional loop administration may be necessary to ensure that this interference does not occur. Such administration may take the form of BA-NY claiming its existing digital services, and even <u>its</u> version of xDSL, are protected services, and placing the onus entirely on other xDSL providers to avoid interference with these services. The resulting discrimination would severely disadvantage other providers of xDSL. Finally, and most significantly, xDSL is designed as a wire pair technology, and it must be provisioned differently when customers are served by a fiber optic digital loop carrier (DLC) system.

61. Concerning the last of these limitations, a loop is composed of two portions, feeder and distribution. The feeder portion extends from the CO to a so-called Feeder-Distribution Interface

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[21] One major variant of ADSL, often called "ADSL G.lite" (or just "ADSL Lite") for its international standards designation, does not require separate equipment at the customer's premises except for a modem card that is plugged into the customer's PC.

in a cable enclosure located no more than two or three miles from the premises served by that loop. Feeder cables typically have a large "cross-section" – that is, a large number of premises are served by a single feeder cable that typically contains a large number of wire pairs. The distribution portion of the loop extends the remainder of the way from the FDI to the premises. Here, the number of pairs in the cables are smaller, since each cable typically serves only a small number of customers.

62. In a DLC system, the feeder portion of the loop does not consist of individual wire pairs, but of a fiber optics transmission system in which individual voice signals are digitized, multiplexed (combined into a higher-bit-rate composite signal) and converted to optical form for transmission between the CO and a remote terminal located at or near the FDI. While such a fiber optics system utilizes a high bit rate, the system, like the interoffice portion of a voice network, is "circuit-oriented" – that is, the bandwidth is organized and allocated to efficiently carry narrowband digitized voice signals.[22]

63. For such a DLC system to carry ADSL, several things must happen. First, the DSLAM must now be located at the remote terminal, rather than in the CO. Second, special plug-in cards in the remote terminal and CO end of the fiber system must be utilized to carry the ADSL bit stream, which is a far higher bit rate than the digitized voice signal, over the fiber optics system. Third, when this is done, ADSL consumes far more bandwidth per customer than does a digitized voice signal. Thus, unless either the fiber optics electronics are upgraded to a much higher bit rate, or spare fibers are used to carry the ADSL signals, there may not be sufficient

[22] DLC systems do not require fiber optics transmission systems. DLC systems were originally designed to operate on copper wire pairs. However, the purpose of DLC systems is to increase the efficiency of feeder facilities by multiplexing many signals onto a single transmission facility, and since that efficiency can best be achieved by using fiber optics, it would be unusual to find in practice today DLC systems on cooper feeder pairs.

capacity in the DLC system to serve any significant number of ADSL customers. In either case, the solution is expensive, less efficient than the wire pair system because it consumes so much of the DLC system's capacity, and requires considerably more administration – for instance, to assign multiple channels or extra fibers to xDSL – than does a DLC system used solely for voice.

64. In summary, ADSL is the technology most favored by incumbent telephone companies in the near term[23] to provide the access portion of the broadband network that society is increasingly demanding. But DSL has some significant issues to resolve before it can be widely deployed. Loop administration is complicated by the need to carefully assign wire pairs and/or digital capacity needed to carry high-speed digital signals. Additional administration is required to properly combine voice and data signals on the same loops. The proper interconnection of the DSL bit stream with fast packet switches in the CO or at an interconnection hub requires rigorous attention to the appropriate interconnection standards; the relatively little experience with such interconnection suggests there will likely be numerous "bugs" to work out.

65. In addition to such technical difficulties, Section V will discuss how DSL creates additional opportunities, even while the popularity of the Internet provides additional incentives, for anti-competitive, discriminatory behavior on the part of BA-NY.

F. Developments in Common Channel Signaling Systems and the Advanced Intelligent Network

66. In addition to transmitting a customer's actual telephone message or conversation, a telephone network must also convey other information associated with setting up, disconnecting, and otherwise controlling the call itself. The transmission and reception of such control

[23] In recent months, there has been a flurry of articles about the use of so-called passive optical networks ("PONs") that would extend fiber to a curb-side pedestal serving a number of residences, or all the way to the individual premises. Past studies of the cost of such networks have shown their costs to be fairly prohibitive.

information between the customers and the network or between elements (e.g., switches) within the network is called signaling.

67. Examples of signaling information are the address of the called party and an indicator that the called party has answered a call or the originator has "hung up" after completing a call. The network uses this information to route and connect each call and to properly bill for it.

68. Until the early 1980's, signaling in the telephone network was carried within the same channel or path that carried the telephone conversation or message. This was done by sending audible (Multifrequency, or "MF") tones; accordingly, the technique was called "in-band" signaling. By contrast, with common channel signaling, signaling information is exchanged via a packet switch data network that is separate from the conversation path. The current arrangement, now widely deployed throughout both LEC and IXC networks, is called Signaling System 7 ("SS7"). There are numerous advantages to signaling via SS7, including significantly faster signaling (hence faster call set up), greater flexibility, higher reliability, and elimination of the potential for customer fraud through mimicking signaling tones.

69. SS7 is a crucial component of not only ordinary calling, but also of current and future network-based services:

> CCS [common channel signaling] is a critical component of the emerging, and still evolving, intelligent network architecture. . . . SS7 message packets contain information ranging from the most basic call connect and disconnect functions to sophisticated query and response transactions between network switches and databases. Databases can be used to provide the intelligence governing call disposition of 800 Database Service, Alternate Billing Service (ABS), Calling Name Delivery (CNAM), automated registration and routing information for Personal Communications Services (PCS), and to support emerging Intelligent Network services and new functionality such as Local Number Portability.[24]

[24] Bellcore Notes on the Network, SR-2275, Issue 3, December, 1997, p. 14-2.

Current SS7-based offerings include Calling Card, 800-Number, and CLASS^{SM} services.[25] The latter include automatic callback, automatic recall, calling number/name identification, selective call acceptance/rejection, distinctive ringing, customer originated call time and several others.[26]

70. In addition to performing signaling functions, SS7 provides network control:

> SS7 is really a *control* network, as well as a signaling network. This is important to understand, because as the Information Highway rolls out, and as the Advanced Intelligent Network (AIN) is implemented, SS7 will be relied upon almost exclusively as a means for telephone companies and other service providers to share database information and switching control without human intervention.[27]

Thus, SS7 not only improves and enhances the signaling associated with conventional voice services, it is also a critical element in the development and deployment of Advanced Intelligent Networks.

71. What is AIN?[28] In the traditional telephone network, all of the instructions or service logic on how to process or route a call are contained within the local switching platform itself. This means that, if the local exchange carrier wants to introduce a new service, it has to wait for the manufacturers to develop the required software, and then it has to install the new software in each of its local (end office) switches. By contrast,

> The Advanced Intelligent Network (AIN) is an evolving network and service control architecture which the Local Exchange Carriers (LECs) are deploying. . . . The basic concept of AIN is to migrate some service control functions from the switch to a LEC-programmable system so new services can be created rapidly and

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[25] CLASS was originally an acronym for the term Custom Local Area Signaling Services. It is now used as a Telcordia Technologies service mark for a collection of telephone company-provided services.

[26] Bellcore, BOC Notes on the LEC Networks, Special Report SR TSV-002275, Issue 2, April, 1994, pp. 14-13 through 14-19 ("Bellcore Notes").

[27] Russell, Travis, Signaling System #7, McGraw-Hill Series of Computer Communications, McGraw-Hill, New York, 1995, p. xvi.

[28] The generic term for the developments described in this section is intelligent networks. In the United States, the most prevalent deployment scenario is provided by Telcordia Technologies' Advanced Intelligent Network -- AIN -- architecture.

> independently of the traditional switch vendor generic release cycles. AIN relies on the Common Channel Signaling/Signaling System 7 (CCS/SS7) protocol and provides a set of service-independent capabilities to allow the LECs and their customers to program new services.[29]

72. In AIN, databases and computer platforms called Service Control Points (SCPs) are added to the network and located at a central point outside of the existing central office switches. This allows the local exchange carrier to develop new and customized services more quickly, at lower cost, independently of the provider of the local switching equipment. The local exchange switches, referred to as Service Switching Points (SSPs) in the AIN, are equipped to recognize certain triggering events such as when a subscriber dials a particular sequence of numbers, e.g., 1-800 or 1-888. When the trigger is activated, the switch (SSP) sends a message containing information about the call over the SS7 network to the remote SCP asking for instructions on how the call is to be routed.[30] The SCP then sends the routing instructions back to the SSP.

73. The SCP can be used to route a call to a given number differently depending upon the calling number, the geographic location of the called party, the time-of-day, additional information requested from and provided by the person placing the call (e.g., by the network furnishing voice prompts asking the user to enter additional digits such as a Personal Identification Number -- PIN), information provided by the called party, the status of the called line, or conditions in the network. For example, a national hotel chain with multiple reservation

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[29] Bellcore Notes, Section 14, p. 14-58.

[30] The logic and information necessary to route a call when a trigger is encountered does not have to reside at a remote location. It may be contained in a computer that is attached to the local switch or SSP. This device is called an Intelligent Peripheral or adjunct. Separating the service logic from the switch in this manner has significant advantages. Conceptually, the AIN architecture allows the "intelligence" to be distributed throughout the network in an optimal way -- locally (e.g., in the Intelligent Peripheral or adjunct) as well as regionally or nationally (in an SCP).

centers can designate the reservation center to which calls from particular Area Codes are routed during the day, while specifying that calls from all area codes should be directed to a single reservation center location at night. In fact, routing to the reservation centers can even be adjusted dynamically based on the current volumes of calls being handled at each reservation center.

74. Note that the Intelligent Network concept means that, in essence, the local exchange network is becoming increasingly programmable or software driven. This allows the carrier to develop new and customized services more quickly and efficiently. Indeed, the AIN vision has been characterized as representing "a true software-only architecture in the public network, separating call transport from control,"[31] and "clearly the future of the public network."[32] Viewed in this way, the service logic is analogous to the application software residing in a computer (e.g., a word processing or spreadsheet program) and the basic call processing functionality is roughly analogous to an operating system (e.g., UNIX or DOS).

75. Deployment of SS7 is thus producing innovative new services and greater efficiencies. At the same time, however, the interconnection of SS7-based networks is more complex than the interconnection of networks using traditional in-band signaling techniques, due to the added interfaces, access to Service Logic and databases at remote locations, and software-based programmability. This complexity is heightened by the expanded role that SS7 plays as a control network and central nervous system of the modern telephone network.

76. What is more, the complexity is likely to increase over time as even more advanced concepts are implemented. A research paper contrasts programmable networks like the AIN with another forward-looking concept, that of an "active network." It notes that:

[31]Fried, Jeff, "Extending CTI's Reach," Telephony (October 21, 1996), p. 46.